

Monthly Progress Report
for the period
September 1 to September 30, 1969

NASA Contract NAS 9-8247

Final Design and Flight Qualification of a
Hypergolic Electrical Power System (HEPS)

Contract effort during September was directed toward:

1. Assembly of the Qualification Unit.
2. Documentation of design changes found necessary during assembly.
3. Determination of the weight, center of gravity, and the moment of Inertia of the Qualification Unit.
4. Installation of the Qualification Unit in the Roanoke/VPI altitude chamber for test.
5. Calibration of Instrumentation.

Specific accomplishments during September are as follows:

1. Assembly of the Qualification Unit was completed on September 18 after which the weight, center of gravity and the moment of inertia was obtained experimentally. Weight of the complete unit is 191 lb including all plumbing, electrical harness, and mounting bolts.

FACILITY FORM 802	N69-79680	
	(ACCESSION NUMBER)	(THRU)
	9	None
	(PAGES)	(CODE)
	CR-101963	03
	(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

During leak test a porous pump housing casting was found to be leaking slightly. This part was removed and weld repaired and the unit reassembled and delivered to Roanoke/VPI on September 23.

2. Installation of the unit and calibration of instrumentation was completed on September 30. Gas generator tests for the purpose of setting mixture ratios are planned for October 1. This will be followed by system tests.

Progress through September is further presented below:

Flight Package Assembly

The package assembly was completed and shipped to the test site in late September. Assembly progressed satisfactorily with only minor modifications encountered. All such modifications have been documented. Some design improvements were apparent and are presently being detailed for part fabrication. These improvements will be incorporated after the unit returns to TRW for preparation for shipment to NASA-HOUSTON; the improvements are as follows:

1. Speed control deployed lock mechanism contains significant "backlash" and will be reduced by eliminating two index keys and making parts simpler.
2. Modification of lube line configuration at inlet to oil radiator to move parts farther away from the hot turbine scroll radiator fin.
3. Modification to bracket that holds control panel and voltage regulator to frame to avoid O/F line drag across bracket edge during package deployment.
4. Add small deployable thermal blanket to top of reflector edge, which deploys to prevent cold plate from thermally viewing the hot turbine scroll radiator fin.

The new set of extension mechanism slides with steel release and lock mechanisms performed quite satisfactorily and provide a rigid deployed configuration.

Thermal insulation blankets and electrical harnesses were tailored to the unit after all components were assembled. The insulation blankets were composed of multiple radiation layers of aluminized polyimide film and were applied to areas where intercomponent heat exchange is to be minimized. Harnesses were routed in a manner to minimize wire lengths and attachment points, and no difficulties were encountered in this process.

Electrical System

All electrical system work except the fabrication of harnesses was completed in September. After assembly of the Qualification Unit, these harnesses were fabricated, routed, and laced together to provide a neat appearance. Continuity checks were then made in both the stowed and deployed positions to insure proper functioning.

Gas Generator

A high emissivity coating consisting of iron titanate was sprayed on the gas generator and its copper cooling fin. This was done to further control the heat soak-back into the injector head at shut-down. This will be the first time this particular feature has been incorporated. Appreciable improvement is expected.

Testing at the Roanoke/VPI Lab

During the last five days of September, the unit was installed in the altitude chamber, instrumentation was calibrated and the altitude system was checked out. During the first vacuum test of the altitude chamber, water condensate from the steam line to the boiler was drawn into the chamber by the vacuum. This caused flooding of the speed control assembly which is located near the bottom of the chamber. It was necessary to remove the control to permit drying and bench electrical checks.

Other Topics (as specified in the contract)

A. Manpower Status

During September the average level of manpower remained at the equivalent of ten full time personnel. In certain areas such as drafting, part time activity is now possible.

B. Testing Status

This activity is described above under Testing at the Roanoke/VPI Lab.

C. Qualification Status

The Qualification Unit is now at Roanoke for Acceptance Test. No Qualification Test will be conducted due to contract revision.

D. Mass Property Status

The mass properties for the HEPS were measured prior to shipment to the test site. The coordinate system used is shown in Figures 1 and 2 and does not relate to the "LM" coordinate system because the sides of the SEQ Bay No. 2 envelope for the HEPS are at 45° angles with the "LM" system. The coordinate system shown is identified with three mutually perpendicular datum planes on the "LM" and can therefore be translated and rotated to the "LM" system. In the data presented the x, y and z axes pass through the HEPS center of gravity.

The HEPS was weighed at 191.0 lb, exclusive of oil, which is 8.5 lb at 4 quarts inventory. A breakdown of various component weights is shown in Figure 3 so as to identify various weight concentrations in the package.

The center of gravity and moments of inertia about the three principal axes were measured by a standard gravity pendulum method. The center of gravity is shown located with respect to the three "LM" datum planes in Figures 1 and 2 and the moments of inertia are as follows:

A. $I_{x-x} = 53 \text{ lb-in.-sec}^2$

B. $I_{y-y} = 54 \text{ lb-in.-sec}^2$

C. $I_{z-z} = 33 \text{ lb-in.-sec}^2$

The moments were calculated by substitution of the required parameters measured during the three different pendulum position motions.

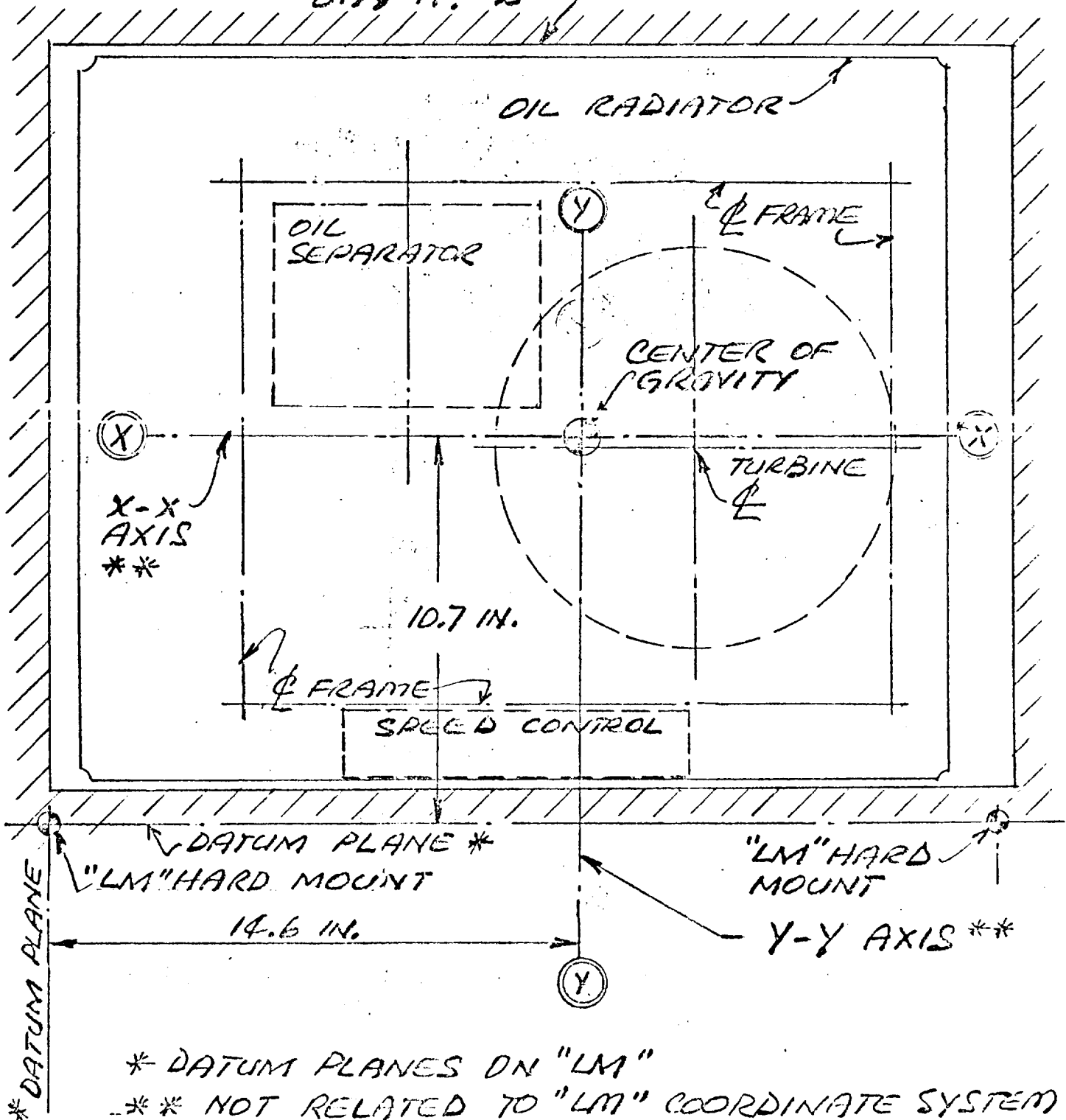
E. Materials Deviation Status

No materials deviations have been required.

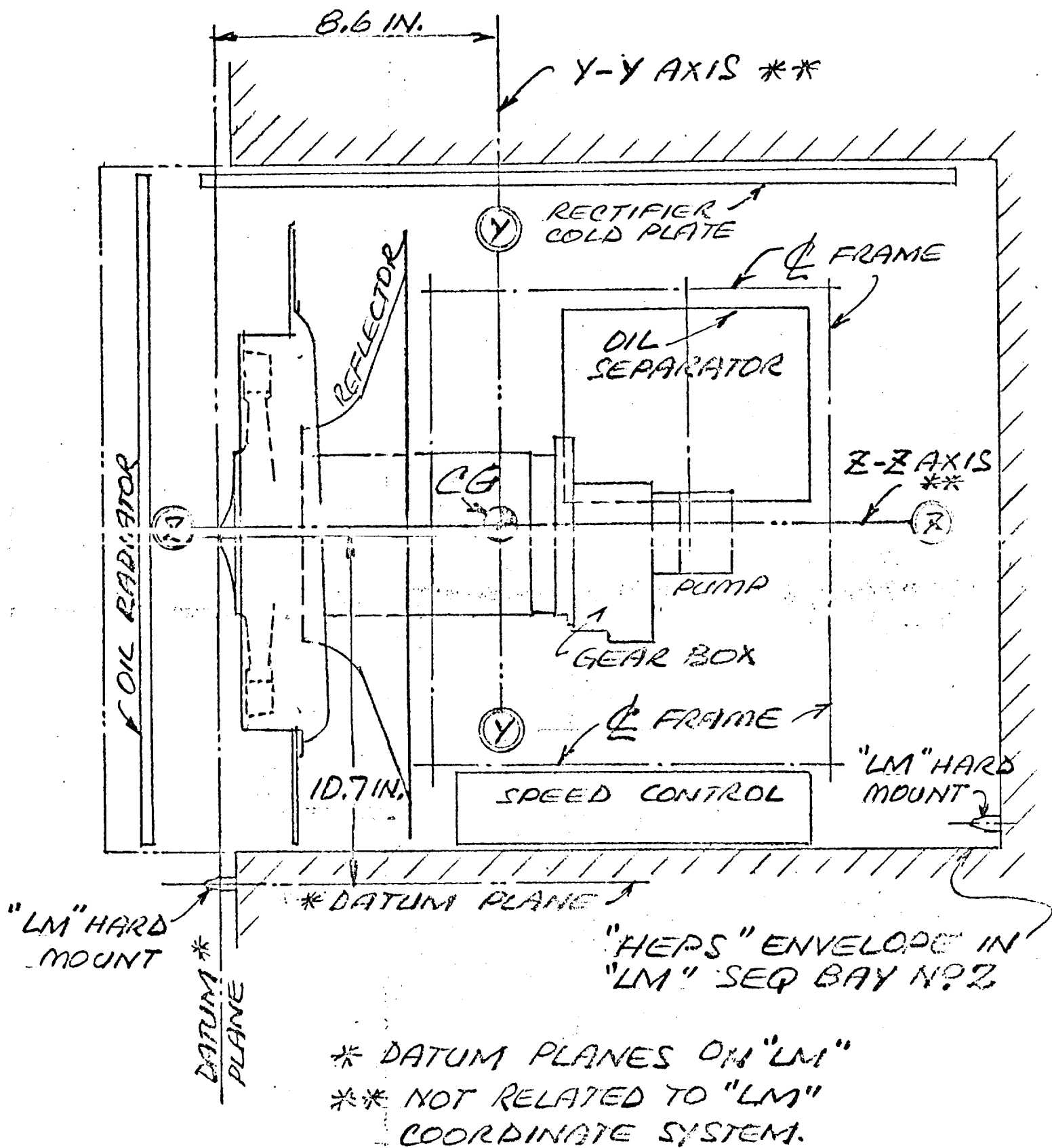
F. Deleted.

VIEW LOOKING INTO "HEPS"
STORAGE BAY

"HEPS" ENVELOPE IN "LM" SEQ
BAY NO. 2



VIEW LOOKING AT "HEPS"
FROM THE RIGHT SIDE



HEPS WEIGHT BREAKDOWN

	<u>Pounds</u>
1. Turboalternator Assembly (817801)	
A. Alternator Assembly (213484)	16.99
B. Turbine Wheel and Shaft (213111)	21.29
C. Seal and Housing Assembly (817831)	0.72
D. Scroll and Nozzle (817834)	20.74
E. Gearbox, Pump and Miscellaneous Hardware	<u>12.95</u>
Subtotal	72.69
2. Lube System	
A. Oil Radiator (213191)	4.37
B. Radiator Hinges, Release, Lock, Mounts	1.04
C. Separator; Dry (213136)	5.40
D. Lube Lines (estimate)	0.5
E. Filter (212954)	0.65
F. Relief Valve (212955)	1.28
G. Low Pressure Switch (estimate)	<u>0.2</u>
Subtotal	13.44
3. Electrical Control System	
A. Control Panel Assembly (212940)	5.07
B. Speed Control Assembly (212941)	7.64
C. Voltage Regulator Assembly (212918)	4.06
D. Rectifier Cold Plate Assembly (213530)	13.44
(Radiator Plates; 3 - 9.19 lb)	
E. Harnesses and Power Leads	Not Weighed
F. Capacitors; 3 (817758)	2.74
G. Power Relay (213381)	2.29
H. Terminals, Receptacles, Miscellaneous	<u>1.25</u>
Subtotal*	36.49

* Not including harnesses and power leads.

HEPS WEIGHT BREAKDOWN (continued)

	<u>Pounds</u>
4. Gas Generator and Control System	
A. Injector and Chamber (817948)	5.90
B. Control Valves (817779)	3.31
C. O/F Manifolds (213415 and 213428)	0.50
D. O/F Hoses (213388 and 213389)	1.78
E. Mounting Brackets and Miscellaneous	2.14
F. Nitrogen Pressurization System	
1) Tank, Safety Adapter and Fill Valve (90861-1, 213486 and 213487)	2.16
2) Solenoid Valve (212984)	0.35
3) Check Valve and Swivel Elbow (92416-4 and 213508-2)	0.15
4) Tubes (estimate)	0.2
Subtotal	16.49
5. Flight Package (817800)	
A. Extension Mechanism, Frame and LM Mount Structure (213220 and 213189)	21.45
1) Two Slides (213286) - 5.58 lb	
2) Frame (213189) - 9.5 Calc.	
3) Five Vibration Mounts (213187) - 2.49 lb	
B. Reflector (814099-31)	4.47
C. Thermal Insulation Blankets	0.75
D. Mounts and Miscellaneous for Control System Boxes (3)	2.68
E. Cold Plate Deployment Hardware	1.99
Subtotal	31.34
6. HEPS Unit Weight, Dry (Measured)	191.0
7. Total of Weights Measured in 1 to 5 above	170.45
*8. Miscellaneous Parts Not Weighed (Item 6 minus Item 7)	20.55
9. Oil at Four Quarts Inventory	8.5
10. Final HEPS Package Weight (Item 6 plus Item 9)	199.5

* A large share of this weight is probably in the harnesses, power leads and some turboalternator parts.

G. Materials and Parts Procurement Status

Procurement of parts is 100% complete.

H. Problem Status

There are no problems of consequence at this time.

I. Meetings with NASA and Subcontractors

None to report.

J. Quality Status

Quality Assurance personnel witnessed the assembly of the Qualification Unit and prepared a listing of all parts used in the assembly. The testing program at Roanoke/VPI is currently being witnessed by Quality Assurance personnel. There are no major Quality Assurance problems to report.

K. Reliability Status

Reliability effort has been discontinued as a result of Qualification Test deletion from the program.

L. Safety Status

No accidents occurred during September.

Work to be performed during October:

Emphasis will be placed upon the following activities:

1. Development testing of the Qualification Unit specifically to insure the proper functioning of the speed control and voltage regulator. These have been flight packaged for the first time.
2. Acceptance testing of the Qualification Unit.
3. High temperature (160°F wall) testing of the Qualification Unit.